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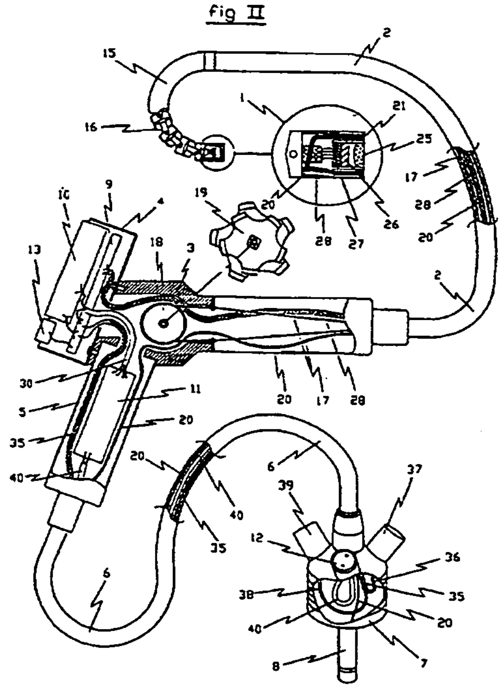
(54) Abstract Title

Video endoscope

(57) A video endoscope comprises an inspection tube (2), terminating in a terminal (1) which houses an objective (25) and a colour CCD sensor (26). The CCD sensor is connected to a video processor (9) which issues a video signal directly to a colour video monitor (10). The processor synchronizes its sampling clock with the signals received from the CCD sensor in order that they are in phase. An optical fibre bundle (20) passes through an umbilical cable (6) from an external light source and extends through the handle (5) and inspection tube, arriving at the terminal (1) to illuminate the target area to be viewed. The external light source is connected via a connection device (7) which also allows for the input of an electrical supply via coupling (12). A direct current electrical supply is thus provided via a cable (40) which forms part of the umbilical cable. The connection device (7) may further incorporate connections for an external video monitor and computer interface. The end of the inspection tube (15) may be articulated in a construction of movable rings (16) which are controlled by two pairs of actuator-controlled cables (17).

fig II



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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fig I

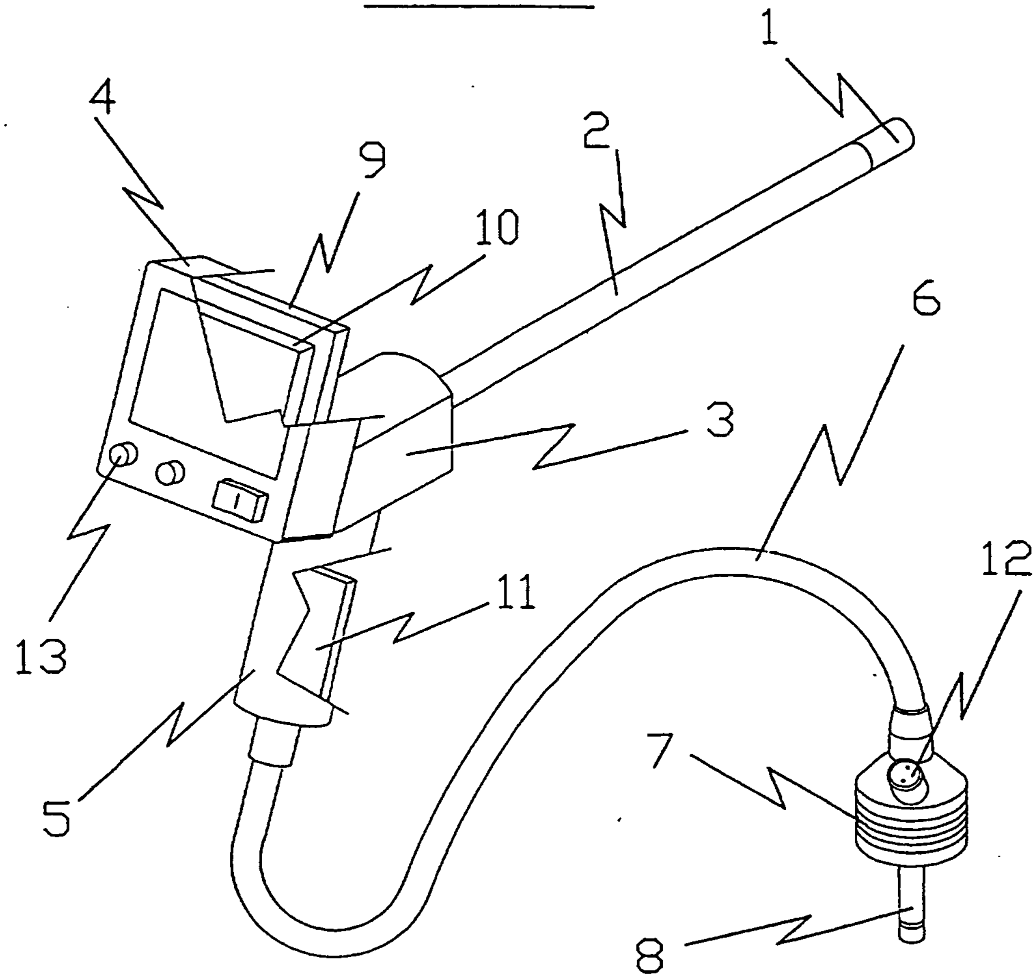

fig II

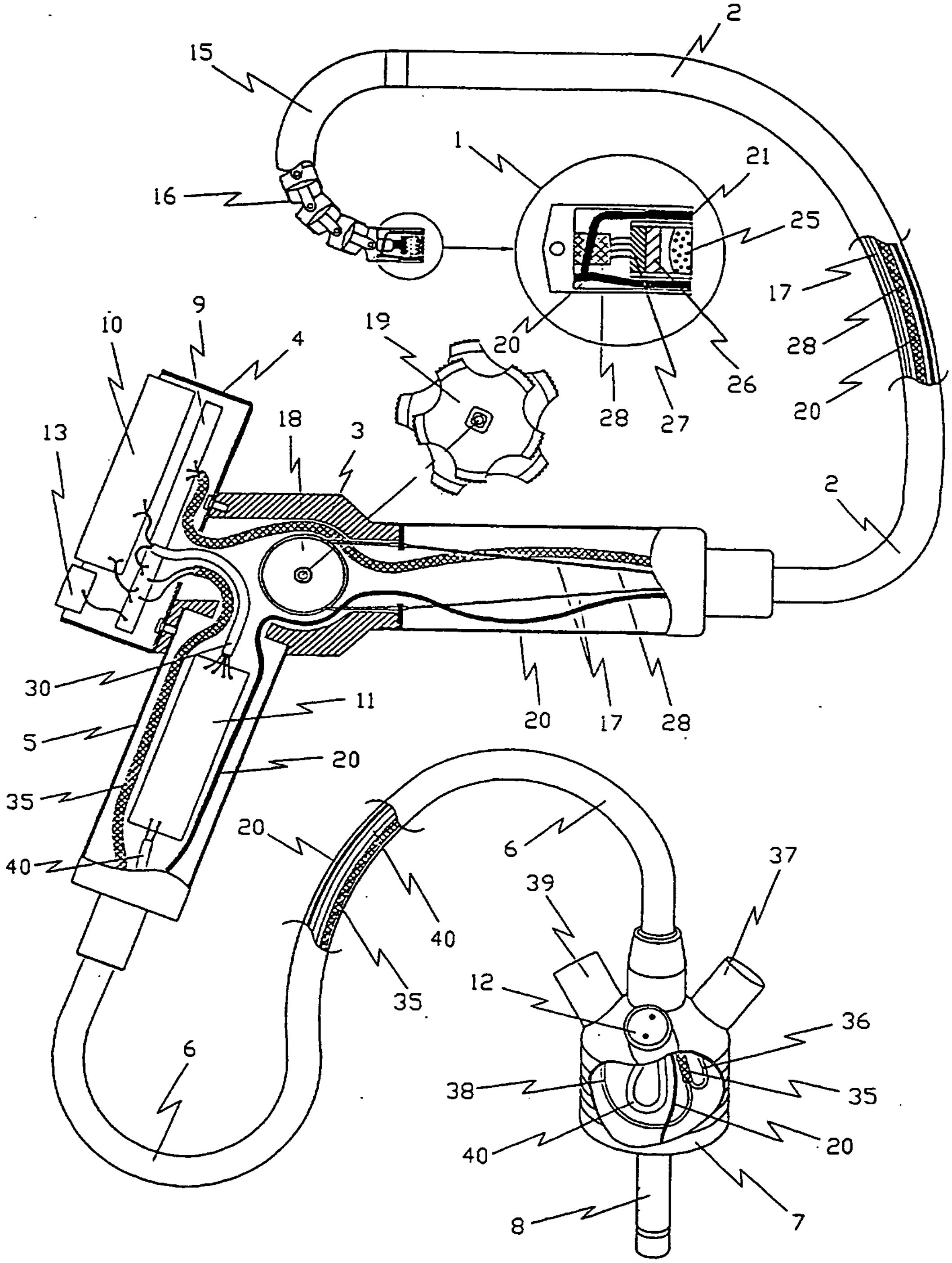
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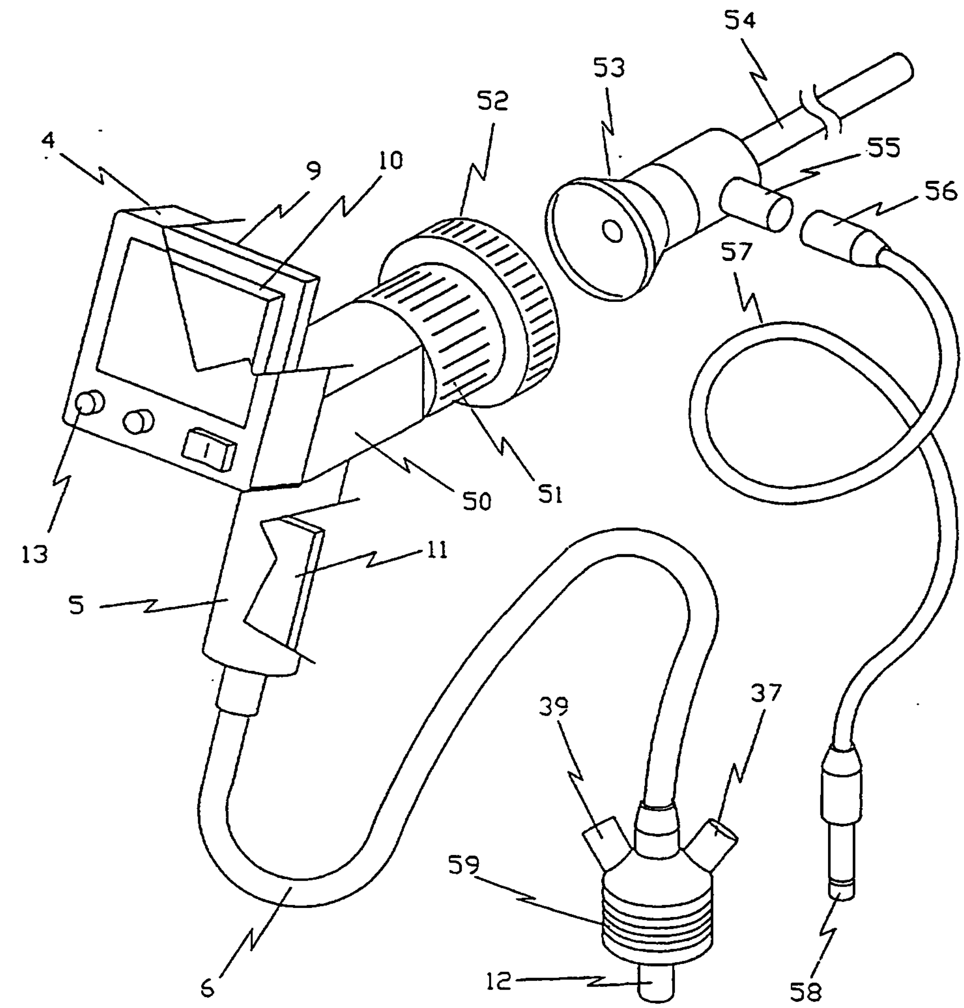
fig III



A VIDEOENDOSCOPE PROBE

The present invention is related to a videoendoscopic probe with a distal color CCD sensor. The technical field of the invention is that of endoscopy devices.

The term "videoendoscopy" designates an examination which allows one to obtain on a television monitor the image of a target situated inside of a dark cavity into which the distal end of a videoendoscopic probe has been introduced. Among the known devices pertaining to color videoendoscopy, it is possible to distinguish two types of videoendoscopes.

The first type covers all the devices in which the image of the target observed inside of a cavity is transmitted by an endoscope or a fibroscope to a color CCD sensor situated outside of said cavity. This first type of videoendoscope corresponds in particular to the cameras with color CCD sensor equipped with a focussing objective and a mechanical connection device allowing the objective of said camera to be locked on the cup surrounding the eyepiece of an endoscope or fibroscope, said camera being connected by an umbilical cable to an external video processor which generates a video signal which can be utilized directly on a color monitor.

The second type of videoendoscope covers all the devices in which the CCD sensor is housed directly in the distal end of the videoendoscopic probe and is therefore introduced inside of the cavity in which the target to be examined is situated. Among the devices arising from this second type of embodiment, it is possible to distinguish two categories of videoendoscopes with distal CCD sensor capable of delivering a color video image.

The first category covers all the devices in which the CCD sensor is a "monochromic" sensor (also called "black and white" sensor) which delivers an electrical signal containing only the luminance information. In this case, obtaining a video signal which can be utilized on a color monitor will require an illumination device which sequentially delivers flashes corresponding to the three primary colors, a device for picking up the video signals generated sequentially by the monochromic distal CCD sensor during the flashes, and a processor making it possible to continually store the last three monochromic video frames in memory and to reconstitute a video signal which can be utilized directly on a color monitor from the three monochromic frames available in memory.

The second category of videoendoscopes with distal CCD sensor covers all the devices in which the CCD sensor is a "trichromic sensor" (also called "color" sensor) which, in association with an illumination device which delivers a permanent and continuous white light, provides an

electrical signal containing the luminance and chrominance information. Said signal is transmitted to a processor which generates a video signal which can be directly utilized on a color monitor.

The present invention arises from this second category of videoendoscopes with distal color CCD sensor, videoendoscopes whose architecture results from the association of the elements described hereinafter.

- A terminal in which is housed an imaging device comprising a distal objective, a color CCD sensor on the photoelectric substrate from which the real image of the target observed by the objective is formed, and an interface microcircuit adapted for correcting the electrical signals received or generated by the CCD sensor.

- A flexible or rigid inspection tube, which does or does not have an articulated distal prop, and whose distal end is associated with the terminal in which the imaging device is housed.

- A control handle whose distal end is connected with the proximal end of the inspection tube.

- An umbilical cable whose distal end is connected with the control handle and whose proximal end is made up of a connection device allowing to connect the videoendoscopic probe to the external electrical devices and light generator necessary for its implementation.

- An illumination device made up of a bundle of non-ordered optical fibers whose distal end, housed in the distal side of the distal terminal, illuminates the observed target when its proximal end, housed in the connection device of the umbilical cable, is connected to a light generator.

- A video processor which ensures the synchronization and electrical supply of the distal imaging device, the processing of the electrical signal generated by said imaging device, and which delivers a video signal which can be utilized directly on a color monitor.

- A color video monitor which displays the image of the target observed by the distal imaging device.

- A light source whose color temperature corresponds to the adjustment of the white balance device integrated in the video processor, source which has a lighting coupling in which the connection device connected with the proximal end of the umbilical cable of the probe is connected.

The difficulties in designing a videoendoscope with distal CCD sensor result essentially from the diversity of the applications requiring a range of probes whose useful lengths can range between 20 cm (for a dental probe) and 50 m (for a tubing inspection probe), and therefore from the need to adapt the characteristics of the video processor as a function of the length of the electrical cable connecting said processor to the distal CCD sensor.

The joint functioning of a color CCD sensor and of the video processor with which it is associated in effect proceeds essentially from correct management of the phase shifts of the different high-speed clocks (14.2 MHz in standard PAL) which are generated by said processor and described hereinafter.

- "Pixel" clocks - This relates to clocks transmitted to the distal CCD sensor, in which they are used, on the one hand, for synchronizing the reading of the electrical voltages contained in the unit cells (called pixels) of the light-sensitive layer of said sensor and, on the other hand, for extracting from these unit voltages the significant information which, after integration, will constitute the electrical signal delivered by the CCD sensor and transmitted to the video processor.

- "Sampling" clock - This relates to a clock used locally for synchronizing the sampling by the video processor of the electrical signal generated by the CCD sensor and transmitted to said processor. The proper functioning of said processor necessarily requiring that the sampling clock be completely in phase with the incident electrical signal. Given the length of the electrical connections connecting said sensor to the video processor with which it is associated, misalignment of the color CCD sensor in the distal end of the videoendoscopic probe introduces a redhibitory phase shift at the level of said processor between the sampling clock and the incident electrical signal. Phase shift which results from the running total of the transmission delay to the CCD sensor of the pixel clocks generated by the video processor and the transmission delay to the video processor of the electrical signal generated by the CCD sensor. The means of remedying such a dysfunction consists of delaying either the sampling clock or the pixel clocks transmitted to the distal CCD sensor by the video processor, and in this way compensating for the overall phase shift mentioned above. The modalities of implementation of one or the other of these delay devices and the connection problems proceeding from them vary as a function of the integration mode of the video processor which can, depending on the architecture used, be external to the videoendoscopic probe with distal CCD sensor or an integral part of said probe.

The videoendoscopes arising from the first type of architecture have a case generally combining a light generator and a video processor, case on which the connection device connected with the proximal end of the umbilical cable of the videoendoscopic probes with distal CCD sensor is connected. The interchangeability of the different probe models which can be connected to the same processor obviously assumes complete compatibility between said processor and said probes, and therefore integration in each probe of a specific delay device. Thus, the videoendoscopic probes with distal monochromic CCD sensor described in US Patent

4 539 586 (Welch Allyn, September 1985) are equipped with a connection box allowing to connect said probes on a case merging a generator of trichromic flashes and a video processor. Said connection box contains two devices allowing to adjust the characteristics of the two pixel clocks provided by the video processor and transmitted to the distal monochromic CCD sensor, and an amplifier allowing to adjust the level of the electrical signal generated by the distal monochromic CCD sensor and transmitted to the video processor. European Patent 0 218 226 B1 (Olympus, October 1986) describes a video processor which has a synchronization generator capable of delivering several sampling clock types corresponding to the number of endoscopic probe models with distal CCD sensor, the connectors of said probes containing an electronic key which, when suitably decoded by the processor, allows said processor to select automatically the sampling clock suited to the connected probe. US Patent 5 434 615 (Fuji Optical, July 1995) describes a videoendoscopic probe with distal color CCD sensor which has a control handle in which is housed the sampler normally associated with the video processor, and an umbilical cable whose proximal end is equipped with a connection box in which the sampling clock generator is housed, clock whose delay is suited to the characteristics of the probe in consideration. Said probe is connected to an external video processor which directly receives the electrical signal delivered by the sampler housed in the control handle of the probe and synchronized by the sampling clock generator housed in the connector of said probe. Outside of the particular configurations described in the patents mentioned above, the videoendoscopic probes which can be connected on an external video processor most often have a delay device integrated in the connector or in the handle of said probe and which acts on the pixel clocks generated by the video processor and transmitted to the distal color CCD sensor. In any case, the main technical disadvantage inherent to this first type of architecture lies in the break of continuity introduced by the connection of the probe, of the electrical connection (conductors and braided ground strap) bringing to the video processor the electrical signal generated by the distal color CCD sensor, electrical signal whose transport proves to be delicate because of its low level as well as its wide pass band. It is also appropriate to note that, even if this type of architecture allows delaying the pixel clock signals transmitted by a video processor to a distal color CCD sensor in such a way as to make videoendoscopic probes of different lengths compatible with the same processor, it does not, for all that, make corrections which would allow compensating for the statistical dispersion of the characteristics of the color CCD sensors implemented in said probes.

The disadvantages mentioned above have been eliminated in the videoendoscopes arising

from the second type of architecture mentioned above and in which each videoendoscopic probe with distal color CCD sensor has its own video processor, said probes being connected to an external case merging a light fixture and a device which delivers the various voltages for the electrical supply of the video processor. With it possible then under these conditions for each processor to be completely adjusted as a function of the length of the probe in which it is integrated (adjustment of the delay of the sampling clock or of the delay of the pixel clocks), as well as a function of the specific characteristics of the distal CCD sensor with which it is associated (adjustments of colorimetry allowing to correct the dispersion of the parameters of the CCD sensor). Thus, US Patents 5 701 155 (Welch Allyn, December 1997) and 5 441 043 (Welch Allyn, September 1992), and European Patents 0 587 514 A1 (Welch Allyn, September 1993) and 0 587 512 A2 (Welch Allyn, September 1993) describe videoendoscopic probes with distal color CCD sensor which are equipped with a connection box connected with the proximal end of the umbilical cable of said probes and used as housing for a video processor. Said box is equipped with a composite connector which is connected on an external box combining a light fixture, the electrical supply for the video processor integrated in the connection box and the means allowing said case to be connected to a color video monitor. The main drawback inherent to the concept described in these two patents results from the need to connect the videoendoscopic probe with distal color CCD sensor to a specific external case in which a light fixture in particular is housed on whose color temperature is fixedly set the device for the white balance adjustment of the video processors integrated in the probe connectors, solution which certainly prohibits the user from free choice of the light source which is implemented.

In any case, the connection device connected with the proximal end of the umbilical cable of a videoendoscopic probe with distal CCD sensor must under these conditions simultaneously ensure the continuity of a certain number of electrical connections and the transmission to a bundle of optical fibers of the light emitted by a light fixture. The connection of videoendoscopic probes which can be connected on a single case (merging light fixture and electrical supply devices, or light fixture and video processor) will generally have a "composite" structure different from the "Y-shaped" structure of the connection devices of probes which can be connected on two distinct cases (for example, a light generator and a video processor).

The six patents mentioned hereinafter relate to connection devices allowing to connect videoendoscopic probes with distal CCD sensor to a single external case. European Patent EP 0 131 971 B1 (Olympus, July 1984) describes a fibroscope connection device capable of ensuring

simultaneously the continuity of a light connection and of several electrical connections, device which could therefore be easily adapted to a videoendoscopic probe with distal CCD sensor. Said device is made up of a cylindrically shaped connector with an axial fibered terminal and several lateral electrical connection pins distributed in an annular manner around the end of said connector. US patent 4 539 586 (Welch Allyn, September 1985) describes a box integral with the proximal end of the umbilical cable of a videoendoscopic probe with distal monochromic CCD sensor and in which an electronic board is integrated which is adapted for ensuring the interchangeability of the probes, the proximal side of said box having a series of connectors allowing to connect simultaneously a light connection and several connections of electrical or pneumatic nature. The particularity of this patent lies in the fact that it describes simultaneously the principle of a composite connector and the integration of an electronic circuit in said connector, a concept which has been used again in US Patents 5 701 155 (Welch Allyn, December 1997) and 5 441 043 (Welch Allyn, September 1992), and European Patents 0 587 512 A2 (Welch Allyn, September 1993) and 0 587 514 A1 (Welch Allyn, September 1993) which relate to endoscopic probes with distal color CCD sensor which are equipped with a composite connection box in which a video processor is integrated. The connection mode described above has been used in particular by the company Welch Allyn (System 2000 and System XT) and by the company Pentax (System EPM 3000).

European Patent EP 0 730 844 A1 (Olympus, September 1996) describes a connection device allowing to associate a videoendoscopic probe with distal color CCD sensor with two distinct cases, and therefore all the more so with a single case. The device described in this patent consists of one cylindrical connector equipped with an axial fibered terminal which is plugged directly into the connecting coupling of a light generator, said connector having a lateral multipin electrical connection coupling on which a multiconductor electrical cable is connected, whose other end is plugged into the connection coupling of a video processor. The drawback of such a connection device, which is implemented by the company Olympus (System Evis 100), lies in the multiplicity of the connections affecting the electrical linkages, certain ones of which transmit electrical signals which have simultaneously a low level and a wide pass band. Other variants of connection devices allowing to associate a videoendoscopic probe with distal color CCD sensor with two distinct cases have also been implemented by the company Olympus; said variants consisting either of fixedly associating a lighting connecting strap with an electrical connector, or of fixedly associating an electrical connecting strap with a lighting connector.

The use of a videoendoscopic probe with distal color CCD sensor obviously assumes that the image of the target situated in front of the distal end of said probe is displayed on a color video monitor, said monitor being most often connected on the external case associated with said probe. The recent miniaturization of LCD technology video screens has enabled the consideration of the integration of a video monitor with a small space requirement in the control handle of a videoendoscopic probe with distal color CCD sensor. The color video monitor integrated in the control handle can be used for purposes other than the simple display of the video image delivered by the videoendoscopic probe with distal color CCD sensor; thus, US Patent 5 373 317 (Welch Allyn, December 1994) describes a videoendoscopic probe with distal color CCD sensor whose control handle has a color video monitor and control joystick; said joystick can be used either for controlling an electrical motorization system integrated in the handle and adapted for modifying the orientation of the distal articulated prop of the probe, or for moving indexes in the image displayed by the video monitor, allowing to manage a program for processing the image displayed on said monitor. The aesthetic appearance of such a control handle having an integrated video monitor and a joystick for control of the prop is described in the US Patent DES.358 471 (Welch Allyn, May 1995). The two patents mentioned above have been implemented in the videoendoscopic probes of the System XT developed by Welch Allyn, probes whose electronic structure corresponds furthermore to European Patent 0 587 514 A1 (Welch Allyn, September 1993). In any case, the integration of a color video monitor in the control handle of a videoendoscopic probe with distal color CCD sensor assumes under these conditions the integration, in the umbilical cable integral with said handle, of additional electrical connections between the video processor and said handle, connections which are adapted for providing said monitor with the video signal and the supply voltages necessary for its functioning.

The present invention has the object of describing a videoendoscopic probe with distal color CCD sensor integrating its own means of processing and displaying the video signal and whose implementation, which is completely automated and similar to that of a traditional fibroscope, would only require the connection to said probe of a commonplace light generator and of an also commonplace electrical energy source.

The present invention also has the object of describing an even more autonomous version of a videoendoscopic probe with distal color CCD sensor integrating, moreover, its own lighting means and whose implementation would under these conditions require no more than a simple connection to a commonplace electrical energy source.

BRIEF DESCRIPTION OF THE INVENTION

The basic version of the videoendoscopic probe with distal color CCD sensor constituting the object of the present invention results from the combination of the following elements.

I/ A distal terminal in which an imaging device is fixedly housed, comprising a distal objective which forms a real image of the observed target on the light-sensitive layer of a color CCD sensor with which it is associated, the proximal side of said color CCD sensor being fixedly integral with an interface microcircuit which is adapted for correcting the electric signals received or generated by the color CCD sensor.

II/ A flexible or rigid inspection tube, which does or does not have an articulated distal prop, and whose distal end is fixedly associated with the distal terminal according to I.

III/ A control handle whose distal end is fixedly integral with the proximal end of the inspection tube according to II. Said handle possibly has some mechanical means necessary for controlling the orientation of the articulated distal prop of the inspection tube according to II.

IV/ A parallelepiped-shaped box mechanically connected with the proximal end of the control handle according to III.

V/ A tubular handle whose distal end is mechanically connected with the lower part of the proximal end of the control handle according to III.

VI/ A flexible umbilical cable whose distal end is fixedly integral with the proximal end of the tubular handle according to V.

VII/ A cylindrical connection device, devoid of any electrical adapting device, whose distal end is fixedly integral with the proximal end of the umbilical cable according to VI and whose proximal side has an axial cylindrical terminal allowing the umbilical cable according to VI to be connected to the connection coupling of a commonplace external light generator. Said connection device is also equipped with a lateral electrical connection coupling adapted for the connection

of a commonplace external electrical energy source which delivers a direct current voltage with a value equal, for example, to 12 Volts and constituting the sole electrical supply of the videoendoscopic probe with distal color CCD sensor.

VIII/ An illumination device made up of a continuous bundle of non-ordered optical fibers running successively without break of continuity through the inspection tube according to II, through the control handle according to III, through the tubular handle according to V and then through the umbilical cable according to VI. The distal end of said bundle of fibers, suitably spread around the imaging device housed in the distal terminal according to I, illuminating the observed target when its proximal end, fixedly housed in the axial cylindrical terminal arranged on the proximal side of the connection device according to VII, is connected to a light generator.

IX/ A video processor housed in the distal part of the box according to IV and connected to the imaging device housed in the distal terminal according to I by a multiconductor electrical cable running without break of continuity through the control handle according to III and then through the inspection probe according to II. The phase shift of the pixel clock generated by the video processor and transmitted by this connecting cable to the distal imaging device (or, another solution, the phase shift of the high-speed clock which synchronizes the sampling by the video processor of the incident electric signal generated by the distal color CCD sensor) is fixedly set continually by means of delay lines as a function of the length of said connecting cable. The processing by the video processor of the electrical signal generated by the distal color CCD sensor and transmitted by this connecting cable being furthermore completely, continually adapted to the specific characteristics of said distal color CCD sensor. The regulation of the level of sensitivity of the video processor according to an automatic control mode acting simultaneously on the device for automatic gain control (AGC) and on the opening of the electronic diaphragm of the color CCD sensor (shutter) allows compensating automatically for great variations of the lighting level of the target and therefore freeing the user from any concern with adjustment of the sensitivity of the video processor and/or of the intensity of the lighting delivered by the light generator. The organization described above therefore makes it possible to continually optimize the functioning of the video processor as a function of the length of the inspection probe, the specific characteristics of the distal color CCD sensor and the lighting level of the target observed. Said organization moreover proves to be particularly favorable for the electrical insulation of the

connections connecting without break of continuity the imaging device housed in the distal terminal according to I to the video processor. Said video processor has a power supply which delivers the various regulated direct current voltages which are necessary for its functioning as well as for that of the video monitor according to X, and of the imaging device housed in the distal terminal according to I. Said power supply is itself supplied by a direct current electrical voltage delivered by the distal end of an electrical cable running without break of continuity through the control handle according to III, through the tubular handle according to V and then through the umbilical cable according to VI, and whose proximal end is supplied by the electrical connection coupling of the connection device according to VII. Said arrangements confirm the advantages offered in the matter of functioning autonomy by the videoendoscopic probe with distal color CCD sensor constituting the object of the present invention.

XI/ A flat color video monitor, for example, with LCD technology, housed in the proximal part of the box according to IV, directly receives the video signal produced by the video processor according to IX housed in the same box and therefore displays the image of the target observed by the imaging device housed in the distal terminal according to I. The integration of a light-weight color video monitor in the control handle according to III of the videoendoscopic probe with distal color CCD sensor constituting the object of the present invention allows avoiding the use of an external video monitor and therefore reinforces the advantages offered by said videoendoscopic probe in the matter of functioning autonomy.

XII/ A panel of sensitive keys integrated on the proximal side of the box according to IV and associated with the digital microcontroller which ensures that the management of the video processor according to IX allows the operator to modify the functioning parameters of said video processor. This panel of keys in particular has an "AUTO LOCK" key allowing to automatically lock the device for adjusting the white balance of the video processor as a function of the chromatic characteristics of the video image of the target observed by the distal terminal according to I and illuminated by the distal end of the bundle of optical fibers of the illumination device according to VIII. Said arrangements make it possible to free the operator from the color temperature of the light generator connected to the videoendoscopic probe and therefore to use any commonly used generator model.

A more sophisticated version of the videoendoscopic probe with distal color CCD sensor constituting the object of the present invention proceeds from the specific arrangements described hereinafter.

- Removal of the umbilical cable according to VI and of the connection device according to VII. - Integration, in the distal end of the tubular handle according to V of the proximal end of the bundle of optical fibers, of the illumination device of the videoendoscopic probe.

- Integration in the tubular handle according to V of a light fixture having a reflector which concentrates the light radiation emitted by said light on the proximal end of the bundle of optical fibers of the illumination device.

- Integration in the tubular handle according to V of an electronic device for the electrical supply of the light fixture, said device being supplied by direct current voltage with a value identical to the supply voltage of the video processor according to IX.

- Integration in the proximal end of the tubular handle V of a multipin electrical connection coupling adapted for being connected on the supply source of the videoendoscopic probe.

BRIEF PRESENTATION OF THE FIGURES ILLUSTRATING THE INVENTION

Figure I illustrates the functional organization of the basic version of the videoendoscopic probe with distal color CCD sensor constituting the object of the present invention.

Figure II illustrates the functional organization of a version with integrated lighting of the videoendoscopic probe with distal color CCD sensor constituting the object of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

FIGURE I

Figure I diagrammatically illustrates the functional organization of the basic version of the videoendoscopic probe with distal color CCD sensor constituting the object of the present invention.

A distal terminal 1, fixedly associated with the distal end of an articulated prop 15, contains an imaging device comprising an objective 25, a color CCD sensor 26 and an interface microcircuit 27 adapted to correct the electrical signals received or generated by said CCD sensor. Said microcircuit particularly ensures the filtering of the supply voltages of the CCD sensor, the shaping of the high-speed clocks for the synchronization of said sensor and the adaptation of the impedance of the electrical signal generated by said sensor.

The prop 15, whose proximal end is fixedly integral with the distal end of a flexible inspection tube 2, is made up of a series of rings 16. Each ring is articulated with its two adjacent rings in such a way that the distal end of said prop can be oriented in two perpendicular planes. The proximal end of said inspection tube is fixedly integral with the distal end of a control handle 3.

The orientation of the prop 15 is controlled by two pairs of cables 17 running through the flexible inspection tube 2. Two mechanical actuators 18 housed in the central part of the control handle 3 act, one, on the pair of cables actuating the orientation of the prop in one plane, and the other, on the pair of cables actuating the orientation of said prop in a plane perpendicular to the preceding one. Two concentric wheels 19, situated on the outside of the handle 3 and whose axes are fixedly and mechanically associated with the actuators 18, allow the user to control the orientation of the prop.

The proximal end of control handle 3 is fixedly integral with the distal face of a box 4. Said box is used as a housing for a video processor 9 housed in its distal part and for a flat video color monitor 10 housed in its proximal part. The functioning parameters of the video processor 9 are adjusted by a panel of sensitive keys 13 situated on the proximal face of said box.

The lower part of the proximal end of the control handle 3 is fixedly integral with a cylindrical piece 50 which has two longitudinal openings 51 and 52 used respectively as passages for the bundle of illuminating fibers 20 and for the multiconductor electrical cables 35 and 40 connecting said control handle to the connection devices of the videoendoscopic probe.

The cylindrical piece 50 is used as a support for the distal end of a cylindrical tubular handle 5 whose proximal end is fixedly integral with the distal end of an umbilical cable 6. The proximal end of the umbilical cable 6 is fixedly integral with the connection device 7. The proximal end of said connection device has an axial cylindrical terminal 8 allowing to connect the videoendoscopic probe to a commonplace external light generator. Said connection device also has three multipin electrical connection couplings 12, 37 and 39. The coupling 12 allows connecting the videoendoscopic probe to an electrical energy source. The coupling 37 allows possibly connecting an external color video monitor on the videoendoscopic probe. The coupling 39 allows possibly connecting the videoendoscopic probe to the RS 232T interface of an external computer.

The illumination device of the videoendoscopic probe is made up of a continuous bundle of non-ordered optical fibers 20 running successively without break of continuity through the inspection tube 2, through the control handle 3, through the longitudinal opening 51 of the cylindrical piece 50, through the handle 5, through the umbilical cable 6 and through the connection device 7. The distal end 21 of said bundle of fibers, suitably spread around the objective 25 housed in the distal terminal 1, illuminates the observed target when its proximal end, fixedly housed in the cylindrical terminal 8 of the connection device 7, is connected to a light generator.

The video processor 9, housed in the box 4, is directly connected to the interface microcircuit 27 associated with the distal CCD sensor 26 by a multiconductor electrical cable 28 running successively without break of continuity through the control handle 3 and through the inspection tube 2. Traveling through said cable are the supply voltages for the CCD sensor, the slow "line" synchronization clocks for the CCD sensor (including in particular the control clock for the electronic diaphragm of the CCD sensor), the high-speed "pixel" synchronization clock for the CCD sensor and, in the reverse direction, the electrical signal generated by the CCD sensor. The video processor 9 has one delay line allowing to phase shift the pixel clock generated by said video processor and transmitted to the electrical interface microcircuit 27 associated with the distal CCD sensor 26 * in such a way that the clock synchronizing the sampling by the video processor of the electrical signal generated by the CCD sensor is completely in phase with said incident electrical signal.

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* (said interface microcircuit locally generating the integration clock),

The video signal delivered by the video processor 9 is directly transmitted to the video input of a flat color monitor 10 arranged on the proximal face of the box 4. Said video signal is also transmitted to the electrical connection coupling 37 of the connection device 7 by means of a coaxial connection 36 integrated in the multiconductor electrical cable 35 connecting the video processor to said connection device and running successively without break of continuity through the longitudinal opening 52 of the cylindrical piece 50, through the handle 5 and through the umbilical cable 6.

The functioning of the video processor 9 is managed by a control device integrated in said video processor and comprising a digital microcontroller, a memory and an interface circuit to the standard RVS 232T. Said microcontroller is associated with a panel of sensitive keys 13 situated on the proximal face of the box 4 and allowing the operator to modify the functioning parameters of said video processor. Said panel in particular has a key allowing to automatically lock in "AUTO LOCK" mode the device for adjusting the white balance of the video processor as a function of the chromatic characteristics of the color video image of the target observed by the distal terminal 1 and illuminated by the distal end 21 of the bundle of optical fibers 20. Said arrangements then allowing to connect said videoendoscopic probe to a non-specific light generator. The RVS 232T interface circuit of the control device installed in the video processor is connected to the multipin electrical connection coupling 39 of connection device 7 by several conductors 38 integrated in the multiconductor cable 35 connecting the video processor to said connection device and running successively without break of continuity through the longitudinal opening 52 of the cylindrical piece 50, through the cylindrical handle 5 and then through the umbilical cable 6.

The video processor 9 has a power supply which delivers the various regulated direct current voltages necessary for the functioning of said video processor, of the video monitor 10, of the distal color CCD sensor 26 and of the interface microcircuit 27 associated with said CCD sensor. Said power supply is itself supplied by a single direct current voltage whose value can vary greatly around its nominal value. Said power supply is itself supplied by an electrical cable 40 running through the longitudinal opening 52 of the cylindrical piece 50, through the cylindrical handle 5 and then through the umbilical cable 6 and connecting without break of continuity the video processor 9 to the electrical connection coupling 12 of the connection device 7. Said coupling can be connected to a commonplace electrical energy source such as, for example, a storage battery which delivers a nominal voltage of 12 Volts which can vary between 9 and 15 Volts.

FIGURE II

Figure II diagrammatically illustrates the functional organization of a version with integrated lighting of the videoendoscopic probe with distal color CCD sensor constituting the object of the present invention.

This version is characterized by the elimination of the umbilical cable 6 and of the connection device 7, by the integration of a lighting device in said cylindrical handle, and by the integration, in the proximal end of said cylindrical handle, of a multipin electrical connection coupling constituting the sole interface of this version of a videoendoscopic probe. All the other arrangements of said version furthermore remain identical to those previously described in the text relative to Figure I.

The illumination device of this version of a videoendoscopic probe is made up of a bundle of non-ordered optical fibers 20 whose proximal end is fixedly housed in the longitudinal opening 51 arranged in the cylindrical piece 50 fixedly integral with the proximal lower part of the control handle 3 of the videoendoscopic probe. The cylindrical handle 5, whose distal end fixedly surrounds the cylindrical piece 50, is used as a housing for a light fixture 53 which has a reflector calculated so that the light radiation emitted by said light is concentrated on the proximal side 30, suitably polished, of the proximal end of the bundle of lighting fibers 20. The light fixture 53 is electrically supplied by a regulated electronic power supply 54 also housed in the cylindrical handle 5 and whose supply voltage is identical to that of the video processor 9.

The proximal end of the cylindrical handle 5 has a multipin electrical connection coupling 55. This coupling is electrically connected with the proximal end of an internal electrical cable 42 which has a branch circuit 41 which ensures the electrical power supply of the regulated electronic power supply 54 of the light fixture 53, and a branch circuit 40 which ensures the electrical power supply of the video processor 9. Said branch circuit 40 runs, for this purpose, through the cylindrical handle 5, through the longitudinal opening 52 of the cylindrical piece 50 and through the control handle 3. The multipin electrical connection coupling 55 is also electrically connected with the proximal end of an internal multiconductor electrical cable 35 connecting said coupling to the video processor 9 and running, for this purpose, through the cylindrical handle 5, through the longitudinal opening 52 of the cylindrical piece 50 and through the control handle 3. Said multiconductor cable ensures the transmission of the video signal generated by the video processor 9 as well as the RS 232T connection of said processor.

SCOPE OF THE INVENTION

It goes without saying that the applications of the videoendoscopic probe with distal color CCD sensor constituting the object of the present invention can arise from the technical inspection field as well as from the medical field.

It also goes without saying that the present invention is in no way limited to the modes of implementation, of execution or of applications which have just been explicitly described. The present invention rather includes all variants which may come to the mind of the technician on the subject without consequently leaving the scope of the present invention.

CLAIMS

1. A videoendoscope probe with distal colour CCD sensor having an optoelectronic structure comprising:

a distal terminal combining an objective, a colour CCD sensor and an electrical interface microcircuit;

a continuous bundle of optical fibres whose distal end, housed in the distal terminal, illuminates the target when its proximal end is connected to a light generator;

a video processor connected by a multiconductor electrical cable to an electrical interface microcircuit associated with the distal colour CCD sensor; said video processor having the function of supplying and synchronising the colour CCD sensor , processing the electrical signal generated by said CCD sensor, and issuing a video signal which can be used directly by a colour video monitor; and

a colour video monitor;

characterised in that:

the distal terminal is connected with the distal end of a tubular probe whose proximal end is integral with a control handle in which the video processor and the colour video monitor are integrated;

the multiconductor electrical cable runs through the probe and directly and without break of continuity connects the video processor to the electrical interface microcircuit associated with the distal colour CCD sensor;

the colour video monitor directly receives the video signal produced by the video processor;

the video processor has a regulated power supply which delivers the various stabilised direct current voltages necessary for its functioning as well as for that of the video monitor, of the electrical interface microcircuit and of the colour CCD sensor;

said power supply is itself supplied by a direct current electrical voltage delivered by an electrical cable whose distal end is electrically integral with the video processor; said power supply is calculated so that the direct current supply voltage transmitted by the electrical cable can vary around its nominal value (for example, from 9 Volts to 16 Volts for a nominal

voltage of 12 Volts); and

a cylindrical piece is fixedly associated with the proximal lower part of the control handle, said cylindrical piece being fixedly surrounded by the distal end of a cylindrical tubular hand-held handle whose proximal end is used as a support for the connection device of the videoendoscope probe; wherein the cylindrical piece has a first longitudinal opening used for the passage of the bundle of optical fibres and a second longitudinal opening used for the passage of the electrical cable.

2. A videoendoscope probe with distal colour CCD sensor according to claim 1, characterised in that:

the proximal end of the hand-held handle is fixedly integral with the distal end of a tubular umbilical cable whose proximal end is fixedly integral with the distal end of a connection device which is devoid of any internal electrical adaptation device;

the proximal end of the connection device has an axial terminal in which the proximal end of the bundle of optical fibres is fixedly housed;

said bundle of fibres runs successively through the umbilical cable, through the hand-held handle, through the longitudinal opening of the cylindrical piece, through the control handle and through the probe;

said bundle of fibres directly and without break of continuity connects the connection device to the distal terminal;

the axial terminal of the connection device can be plugged directly into the connection coupling of an external light generator;

the connection device has a lateral electrical connection coupling which is electrically integral with the proximal end of the electrical cable; and said cable runs successively through the umbilical cable, through the hand-held handle, through the longitudinal opening of the cylindrical piece and through the control handle; said cable directly and without break of continuity connects the connection device to the video processor; the connection coupling can be connected to an external electrical source.

3. A videoendoscopic probe with distal colour CCD sensor according to claim 2, characterised in that:

the video processor provides a video signal to the distal end of a coaxial cable integrated in a multiconductor cable;

the connection device has a lateral coaxial connection coupling which is electrically integral with the proximal end of the coaxial cable;

the multiconductor cable runs successively through the umbilical cable, through the hand-held handle, through the longitudinal opening of the cylindrical piece and through the control handle; the coaxial cable directly and without break of continuity connects the connection device to the video processor; and

the connection coupling can be connected to a commonplace external video monitor.

4. A videoendoscopic probe with distal colour CCD sensor according to claim 2 or claim 3, characterised in that:

the operation of the video processor is managed by a digital microcontroller which has a standard RS 232T interface allowing to modify its functioning parameters;

said interface is electrically integral with the distal end of an RS 232T link composed of several conductors integrated in the multiconductor cable;

the connection device has a lateral multipin connection coupling which is electrically integral with the proximal end of the RS 232T link;

the multiconductor cable runs successively through the umbilical cable, through the hand-held handle, through the longitudinal opening of the cylindrical piece and through the control handle;

and the RS 232T linkage directly and without break of continuity connects the connection device to the video processor; the connection coupling can be connected to the RS 232T interface of an external computer.

5. A videoendoscope probe with distal colour CCD sensor according to claim 1, characterised in that:

a light fixture fixedly housed in the distal part of the tubular hand-held handle has a reflector calculated so as to concentrate the light radiation emitted by said light on the proximal side, suitably polished, of the proximal end of the bundle of optical fibres fixedly housed in the longitudinal opening of the

cylindrical piece;

the light fixture is electrically supplied by the stabilised voltage delivered by a regulated power supply also housed fixedly in the tubular hand-held handle and whose power supply voltage is identical to that of the video processor;

the proximal end of the tubular hand-held handle has a multipin electrical connection coupling which is electrically integral with the proximal end of an internal electrical cable which has a branch circuit ensuring the electrical power supply of the regulated power supply of the light fixture, and a branch circuit which ensures the electrical power supply of the regulated power supply of the video processor; wherein said branch circuit runs successively through the tubular hand-held handle, through the longitudinal opening of the cylindrical piece and through the control handle;

the multipin electrical connection coupling can optionally be electrically integral with the proximal end of an internal multiconductor electrical cable directly connecting said coupling to the video processor; said cable runs successively through the hand-held handle, through the longitudinal opening of the cylindrical piece and through the control handle; and said cable ensures the transmission of a video signal generated by the video processor and/or the RS 232T linkage with said video processor.

6. A videoendoscope probe with distal colour CCD sensor according to any one of the preceding claims, characterised in that:

the operation of the video processor is managed by a digital microcontroller associated with a panel of sensitive keys situated on the control handle allowing modification of the functioning parameters of the processor; and

the panel of keys has a special key allowing it to automatically lock the device for adjusting the white balance of the video processor as a function of the chromatic characteristics of the video image of the target illuminated by the distal end of the bundle of optical fibres.

7. A videoendoscopic probe with distal colour CCD sensor according to any one of the preceding claims, characterised in that:

the regulation of the sensitivity of the video processor as a function of the lighting level of the target observed occurs according to an automatic control mode simultaneously concerning the gain of the video processor and the opening of the electronic diaphragm of the distal colour CCD sensor, an arrangement which makes it possible to automatically compensate for variations of the lighting level of the target.

8. A videoendoscope probe with distal colour CCD sensor according to any one of the preceding claims, characterised in that:

the phase shift device allowing compensation for the transmission delays of the electrical signals travelling through the multiconductor electrical cable connecting the video processor to the electrical interface microcircuit associated with the distal colour CCD sensor is made up of one delay line acting on the pixel clock generated by the video processor and transmitted to the electrical interface circuit.

9. A videoendoscopic probe with distal colour CCD sensor according to any one of claims 1 to 7, characterised in that:

the phase shift device allowing compensation for the transmission delays of the electrical signals travelling through the multiconductor electrical cable connecting the video processor to the electrical interface microcircuit associated with the distal colour CCD sensor is made up of one delay line acting on the clock which synchronises the sampling by the video processor of the incident electrical signal generated by the distal colour CCD sensor and transmitted by the cable.

10. A videoendoscope probe with distal colour CCD sensor according to any one of the preceding claims, characterised in that:

the distal end of the inspection tube is integral with a prop device whose distal end supports the distal terminal;

said prop device is made up of a series of rings, each ring being articulated with its two adjacent rings in such a way that said prop device can be oriented in two perpendicular planes;

in each of these planes, the movements of said prop device are

controlled by the translational movements in the opposite direction of two flexible cables running through the inspection tube; wherein each pair of cables, assigned to the movements of the prop device in one plane, is driven by an actuator housed in the handle.

11. A videoendoscope probe with distal colour CCD sensor according to claim 10, characterised in that:

the two actuators are exclusively mechanical devices; and each of these actuators is associated directly and mechanically with an external control wheel.

12. A videoendoscope probe with distal colour CCD sensor according to claim 10, characterised in that:

the two actuators are motorised devices; the starting and the rotation direction of the two electric motors of the actuation device are controlled by a joystick with four degrees of freedom situated on the control handle; and the power supply voltages of the two direct current motors associated with said actuators is identical to the power supply voltage of the video processor.

13. A videoendoscope probe substantially as described herein with reference to the accompanying drawings.

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24.

Application No: GB 9925375.9
Claims searched: 1-13

Examiner: J. C. Cowen
Date of search: 2 May 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): H4F FAAA,FAAJ,FAAX

Int Cl (Ed.7): A61B 1/00,1/005,1/04,1/045,1/05,1/06,1/07 H04N 5/225,5/235,7/18

Other: WPI,EPODOC,PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	US4604992	Olympus Optical Company - see figure 1	1
A	WO97/41767	Philip Green	-
A	WO93/15648	Wilk & Nakao	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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